

The Prevalence of Potentially Traumatic Events in Childhood and Adolescence

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This paper examines exposure to potentially traumatic events from middle childhood through adolescence, and vulnerability to such exposure. Analyses are based on the first 4 annual waves of data from a longitudinal general population study of youth in western North Carolina, involving 4,965 interviews with 1,420 children and adolescents and their parents or guardians. Participants reported on *DSM* extreme stressors ("high magnitude events"), other potentially traumatic events ("low magnitude events"), and background vulnerability factors. In this general population sample, one-quarter experienced at least one high magnitude event by age 16, 6% within the past 3 months. One third experienced a low magnitude event in the past 3 months. The likelihood of such exposure increased with the number of vulnerability factors.

KEY WORDS: children; traumatic events; high magnitude events; low magnitude events; vulnerability.

In this paper we examine exposure to potentially traumatic events, vulnerability factors for such exposures, and the effects of traumatic events on access to mental health care in a general population sample of children and adolescents. Over the past two decades, studies of children exposed to *specific* traumatic events have provided a substantial base of information about the behavioral and psychological sequelae of such exposures. Specific experiences studied have included kidnapping (Terr, 1983), shipwreck (Yule, Udwin, & Murdoch, 1990), sniper attack (North, Smith, & Spitznagel, 1994), volcanic eruption (Shore, Tatum, & Vollmer, 1986), flood (Earls, Smith, Reich, & Jung, 1988), hurricane (Shannon, Lonigan, Finch, & Taylor, 1994), sexual abuse (McLeer, Deblinger,

Henry, & Orvaschel, 1992), conditions of war (Saigh, 1991), and community violence (Fitzpatrick & Boldizar, 1993; Freeman, Mokros, & Poznanski, 1993), to name but a few. Little information exists, however, on the developmental epidemiology of traumatic events in general; for example, the frequency with which children in the general population experience one or more of a range of potentially traumatic events, or the factors that affect risk for such exposures (Angold & Costello, 1995a; Costello & Angold, 1995; Finkelhor, 1995).

The few epidemiologic studies of children that exist have tended to concentrate on examining the prevalence of and trends in victimization and maltreatment, most notably physical assault, sexual abuse, and community violence (cf., Leventhal, 1998). A telephone survey of a nationally representative sample of 2,000 children aged 10 to 16 found that over 40% of adolescents reported at least one experience that could be categorized as violent victimization (Boney-McCoy & Finkelhor, 1995). For example, 11% reported experiencing attempted or completed sexual abuse at some time during their life, with 2% reporting contact sexual abuse during the past year (Boney-McCoy & Finkelhor, 1995; Finkelhor & Dziuba-Leatherman, 1994). A survey of past sexual abuse among

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ninth grade students in the midwestern United States found that 10% reported some type of sexual abuse: 2% reported incest, 6% extrafamilial sexual abuse, and 3% both incest and extrafamilial abuse (Hernandez, 1992). Kilpatrick, Saunders, and Resnick (1998) estimated the lifetime prevalence of exposure to sexual assault, physical assault, and witnessing violence as 8, 17, and 39%, respectively, in a national sample of adolescents aged 12 to 17.

A survey of 2,248 students in the 6–8th, and 10th-grades in an urban public school system found that 41% reported witnessing a shooting or stabbing within the past year (Schwab-Stone et al., 1995). Another survey of 3,735 ninth through twelfth-grade students in six high schools also reported high rates of exposure to violence within the past year that varied by size and location of the school (Singer, Anglin, Song, & Lunghofer, 1995). Among male adolescents, 3–22% reported being beaten or mugged in their own neighborhoods, 3–33% reported being shot at or shot, and 6–16% reported being attacked with a knife. Although reported rates of most types of victimization were lower for adolescent females than males, more females than males reported sexual abuse or assault.

A few general population studies of adolescents have gone beyond sexual abuse and personal experience of violence to examine a wider range of exposures to potentially traumatic events, guided by the list of “extreme stressors” provided by the Diagnostic and Statistical Manual of the American Psychiatric Association as potential precursors to posttraumatic stress disorder (PTSD) in adults (American Psychiatric Association, 1994). A study of 384 eighteen-year-olds from a predominantly White, working-class community in the northeastern United States found that 43% experienced a potentially traumatic event during their lifetimes (Giaconia et al., 1995). Witnessing injury to or death of others, hearing news of other’s sudden death or accident, and personally experiencing a sudden injury or accident were the most commonly reported potentially traumatic experiences, with prevalences of 13, 13, and 10%, respectively. Lifetime exposures to natural disasters, threat, narrow escape, other events, and others’ experiences were reported at prevalences near or below 2%. Physical assaults were reported by 7% of the sample, while more females (4%) than males (fewer than 1%) reported ever having been raped.

In a longitudinal study of adolescents and young adults recruited from a suburban public school system in the southeastern United States, 15% of persons 16–22 years of age reported exposure to at least one traumatic event during their lifetime (Cuffe et al., 1998), with females and African Americans reporting greater exposure than males and Whites.

Variations in estimates of children’s risk for exposure to potentially traumatic events may be attributable to methodological differences across the studies in (a) the types of events assessed (e.g., specific types of events, such as physical and sexual assault vs. a wider range of potentially traumatic events); (b) the age, gender, race-ethnicity, urban or rural residence, and representativeness of the study populations; (c) the measurement approach used to ascertain exposure (a single general open-ended question about any exposures vs. separate questions for specific types of events); (d) the data collection methods (e.g., telephone survey, mail questionnaire, face-to-face interview); and (e) the time period over which respondents are asked to recall exposure experiences (contemporaneous vs. retrospective data collection).

Findings from studies of child victimization and maltreatment strongly suggest that vulnerability factors explain a significant amount of the variability in children’s exposure to sexual abuse and physical abuse (cf., Leventhal, 1998). Empirically identified risk factors for child abuse include younger age, female gender, and contextual variables such as the extent of the child’s social isolation, having a young mother, and substance abuse and emotional problems in the child’s family (Brown, Cohen, Johnson, & Salzinger, 1998; Cicchetti & Toth, 1995; Fergusson, Lynskey, & Horwood, 1996; Fleming, Mullen, & Bammer, 1997). The likelihood of child maltreatment also increased with the number of such risk factors. A survey of 644 eighteen-year-old youth found that the prevalence of child maltreatment increased from 3% when no risk factors were present to 24% when four or more risk factors were present (Brown et al., 1998).

This paper examines the prevalence of the *DSM’s* extreme stressors in a general population sample of children and adolescents. Following Kilpatrick and his colleagues’ terminology (Falsetti, Resnick, Kilpatrick, & Freedy, 1994) we refer to the *DSM’s* extreme stressors (listed in Appendix Ai) as *high magnitude events*. However, there is clinical evidence that this list of events, developed mainly in the context of work with adult PTSD, may not encompass all the events that trigger psychiatric disorder in children (e.g., Bailey & Garralda, 1990; Beautrais, Fergusson, & Shannon, 1982; Clark, Lesnick, & Hegedus, 1997; Coddington, 1972; Garrison, Schoenbach, Schluchter, & Kaplan, 1987; Goodyer, Kolvin, & Gatzanis, 1985; Goodyer, 1994; Jackson & Frick, 1998; Johnson, 1986; McFarlane, 1988; Sandberg et al., 1993; Steinhausen & Radtke, 1986; Williamson, Birmaher, Anderson, Al-Shabbout, & Ryan, 1995). In the present study, we wanted to explore beyond the boundaries of the core *DSM-IV* extreme stressors, within the bounds of what was feasible in a comprehensive annual

psychiatric assessment. We also wanted to include other events known to increase risk for anxiety and depression in children and adolescents (see references above). Following Kilpatrick and colleagues (Falsetti et al., 1994), we refer to these additional items as *low magnitude events*, although in fact their relationship to childhood PTSD is currently unclear. We also examine some characteristics of the family and environment that might expose a child to traumatic events, or limit the amount of support available following such an event, and test the hypothesis that there exists a gradient of vulnerability such that the likelihood of potentially traumatic events increases with the accumulation of vulnerability factors over time.

Method

Study Sample

The Great Smoky Mountains Study is a longitudinal study of the development of psychiatric disorder and need for mental health services in rural and urban youth. Details of the study design and instruments used can be found in other papers (Burns et al., 1995; Costello et al., 1996). Briefly, the study was designed to follow a representative sample of children through puberty and adolescence and, eventually, into early adulthood (Angold, Costello, & Worthman, 1998). A fairly poor, predominantly rural area (11 counties in western North Carolina) was selected to provide a contrast with the many current studies of poor urban youth. Using an accelerated cohorts design, (Schaie, 1965) three cohorts of children, age 9, 11, and 13 at intake, were selected from the population of some 20,000 children using a household equal probability design. The accelerated cohorts design means that over several years of data collection each cohort reaches a given age in a different year. This provides the dual advantage of controlling for cohort effects while speeding up the collection of longitudinal data (Kleinbaum, Kupper, & Morgenstern, 1982).

A two-phase process was used to select the final sample for the longitudinal study. A screening questionnaire was administered to a parent (usually the mother) of the first stage sample ($N = 3,896$). The questionnaire consisted mainly of the externalizing (behavioral) problems scale of the Child Behavior Checklist (Achenbach & Edelbrock, 1981), and was administered by telephone or in person. All children scoring above a predetermined cutpoint (the top 25% of the total scores, in this case a score of 20 or more) plus a 1-in-10 random sample of the rest (i.e., the remaining 75% of the total scores), were recruited for detailed interviews. Ninety-five percent of families contacted completed the telephone screen, and

80% ($N = 1,420$) of those recruited agreed to participate. The proportions with complete data at each wave are Wave 1: 94%, Wave 2: 91%, Wave 3: 87%, Wave 4: 78%. Contact is maintained by telephone every 3 months, and families are reinterviewed annually until the child is 16, and every 3 years thereafter. The data presented here, based on the first four annual waves of the study (1993–1996), consist of 4,965 interviews with the 1,420 participants and one parent. The contribution of each participant is weighted by the inverse of their selection probabilities, stratified by age, gender, and race–ethnicity, to provide accurate prevalence estimates for the population of the study area (Cochran, 1995). Thus, the prevalence estimates reported here refer to the population from whom the sample were selected, not the sample itself.

Fewer than 10% of the area residents and the sample are African American. An American Indian reservation, with a population of about 8,000 (around 3% of the population of the 11-county area) was oversampled so that 350 of the interviewed sample (1,233 observations over 4 years) are American Indian. For the analyses presented here, data from this group are also weighted back to population levels. Race was included in all analyses, but no significant differences were observed. Although power was adequate for comparisons between White and American Indian children, it was not adequate for comparisons involving African Americans, and so no firm conclusions can be drawn about the absence of differences between this group and the rest.

Measures

Life Events

The Life Events Interview used in this study was designed to provide the background information needed to make a *DSM-IV* diagnosis of PTSD. The DSM definition of PTSD requires “exposure to an extreme stressor” as a precursor to the disorder, and provides a general description of such events: “direct personal experience of an event that involves actual or threatened death or serious injury . . . or witnessing *such* an event . . . or learning about unexpected or violent death, serious harm, or threat of death or injury experienced by a family member or other close associate” as well as some specific examples of such events, for example: military combat, violent personal assault (sexual assault, physical attack, robbery, mugging), being kidnapped, being taken hostage, terrorist attack, torture, incarceration as a prisoner of war or in a concentration camp, natural or manmade disasters, severe automobile accidents, or being diagnosed with a

life-threatening illness. For children, sexually traumatic events may include developmentally inappropriate sexual experiences without threatened or actual violence or injury (APA, 1994, p. 424).

High magnitude events. The high magnitude events section of the Life Events Interview is designed to implement this definition as closely as possible. It takes each event listed in the *DSM* (see Appendix Ai), and asks questions designed to establish whether such an event has occurred to the child, and if so, when. The version of the interview used here inquires about every *DSM* category except *military combat* and *incarceration as a prisoner of war or in a concentration camp*, events currently rare for children in the United States (such events can, of course, be added to the interview if needed). As examples, Figs. 1 and 2 show the interview coding pages for the items "Learned about an event that caused, or had potential to cause, severe injury or death" and "Victim of physical violence (not abuse)." Interviewers are required to use set questions and probes to code whether the event occurred, its date, who did it, and to whom. For some items, severity (e.g., of physical abuse) is coded. Interviewers also tape record and make notes on the events described.

In the case of events such as physical abuse or being the cause of harm to others, interviewers code the subject's relationship to the perpetrator or victim, the level of intentionality, and the availability of social and emotional support. The child or parent is then asked whether the event affected "any of the problems we have been talking about," with reference to the 17 symptom areas that have already been reviewed during the psychiatric assessment that precedes the life events interview (see below). This provides an attributional link between the event and one or more comorbid psychiatric symptoms. Screening items for painful recall, hyper vigilance, and avoidance, the three core dimensions of PTSD follow. If these core symptoms are present, the participant completes a detailed module that covers the full range of PTSD symptoms. However, an event that meets the Glossary criteria is coded as present irrespective of the respondent's score on the PTSD screen.

At each interview we asked about high magnitude events occurring at any time in the child's life. Thus, the same event was often reported in several interviews, and, of course, by both parent and child. An event was coded as present if reported by parent, child, or both, and dated by the earliest reported date, if these differed. Multiple reports of the same event thus only count once toward the prevalence estimates reported in this paper.

Low magnitude events. The second set of potentially harmful events, referred to as low magnitude events (Appendix Aii), was culled from the literature on childhood psychopathology. Sometimes the consequences of

an event determine whether it is counted as high or low magnitude; if, for example, pregnancy results in a termination or stillbirth, that death is counted as a high magnitude event. Following Brown and Harris's work on loss and threat (Harris & Brown, 1985), death of a close family member counts as a high magnitude event if it involves a parent, caretaker, sibling or best friend, but not if it involves a noncaretaking grandparent or other second degree relative. An *other* category is included at the end for events not reported under any of the previous headings.

Previous research suggested that low magnitude events would be reported more frequently than high magnitude "extreme stressors." To reduce the burden on parents and children, we only pursued the screening questions for PTSD, and if necessary the PTSD section of the interview, if a low magnitude event had occurred in the past 3 months (the time frame for most of the CAPA interview). Thus, prevalence of high magnitude events across the period of risk is reported (i.e., lifetime risk, adjusted for the number of years of exposure; i.e., age), and also for the average of the 4 three months preceding the interviews, whereas the prevalence of low magnitude events is averaged across the 3-month periods preceding the 4 interviews. Procedures for developing these estimates, taking into account the sampling design, are described below.

The interview used to collect the information about potentially traumatic events was designed for use in epidemiologic studies of the prevalence and development of psychiatric disorders and risk factors for those disorders. PTSD is only one of the disorders covered, and for potentially traumatic events only some of the risk factors were examined. As a result, the questions are not as detailed as would be the case in a clinical study devoted to PTSD or to children exposed to a particular risk factor, such as sexual abuse or family violence. They are also designed so as not to upset children who have not been exposed to an event, while encouraging those who have been exposed to talk about it if they choose. As a result, some of the questions (e.g., those referring to sexual abuse) do not mirror the standard clinical or survey approaches. They were, however, designed after extensive consultation with child psychiatrists expert in the clinical and epidemiologic assessment of trauma.

The Life Events Interview is a section of the *Child and Adolescent Psychiatric Assessment* (CAPA), a psychiatric interview for children aged 9 through 17. The CAPA is an interviewer-based interview (Angold & Fisher, 1999; Angold et al., 1995). The goal of interviews using this format, such as the Present State Examination or the Schedules for Clinical Assessment in Neuropsychiatry (Wing et al., 1992; Wing, Cooper, & Sartorius, 1974), designed for use with adults, is to combine the advantages

Definitions and questions

LEARNED ABOUT EVENT THAT CAUSED, OR HAD POTENTIAL TO CAUSE, SEVERE INJURY OR DEATH

Person learned about, but did not see or hear, an event with serious potential for life threat or severe physical injury to a loved one (e.g. first or second degree relative, or a close personal friend).

CODE DEATH OF LOVED ONE ON PAGE 353.
CODE DEATH OF SIBLING OR PEER ON PAGE 354.

**Has someone you really care about ever had anything really terrible happen to him/her?*

Or been badly hurt?

Or been beaten up?

What happened?

IF EVENT EVER PRESENT, COMPLETE ATTRIBUTION AND PAINFUL RECALL. OTHERWISE SKIP TO LEARNED ABOUT EXPOSURE TO NOXIOUS AGENT

ATTRIBUTION

**In the last 3 months, has "life event" affected any of the problems we have been talking about?*

Which ones?

In what way?

PAINFUL RECALL

**In the last 3 months have thoughts or pictures of "life event" come into your mind?*

**Even when you didn't want them to?*

What was that like?

Have you had any nightmares about the event?

IF PAINFUL RECALL PRESENT, ASK AVOIDANCE AND HYPERAROUSAL.
OTHERWISE SKIP TO NEXT LIFE EVENT.

AVOIDANCE

**Do certain things remind you of "life event"?*

What things?

Do you try to avoid these things/thoughts?

HYPERAROUSAL

**Since "life event", have you been more jumpy or irritable?*

**Have you had any trouble sleeping?*

**Have you been "on the alert" for bad things happening?*

IF ALL SCREENS ARE POSITIVE, PLACE CHECKMARK ON PTSD CHECKLIST

Coding rules

EVER: LEARNED ABOUT EVENT

- 0 = Absent
- 2 = Present, to friend
- 3 = Present, to 2nd degree relative
- 4 = Present, to 1st degree relative

EVER: PERPETRATOR

- 0 = No perpetrator
- 2 = Unknown perpetrator
- 3 = Acquaintance
- 4 = Friend
- 5 = Family member

LEARNED ABOUT EVENT

- 0 = Absent
- 2 = Present, to friend
- 3 = Present, to 2nd degree relative
- 4 = Present, to 1st degree relative

PERPETRATOR

- 0 = No perpetrator
- 2 = Unknown perpetrator
- 3 = Acquaintance
- 4 = Friend
- 5 = Family member

ATTRIBUTION OF LIFE EVENT AS CONTRIBUTING TO PROBLEM WITH:

- 1 = School non-attendance
- 2 = Separation anxiety
- 3 = Worries/anxiety
- 4 = Obsessions/compulsions
- 5 = Depression
- 6 = Mania
- 7 = Physical symptoms
- 8 = Food-related behavior
- 9 = Hyperactivity/ADD
- 10 = Conduct disorder
- 11 = Alcohol/drugs
- 12 = Psychosis
- 13 = Relationships with parent #1 and/or parent #2
- 14 = Relationships with other parent #1 and/or other parent #2
- 15 = Relationships with other adults
- 16 = Sibling relationships
- 17 = Peer relationships

PAINFUL RECALL SCREEN

- 0 = Absent
- 2 = Present

AVOIDANCE SCREEN

- 0 = Absent
- 2 = Present

HYPERAROUSAL SCREEN

- 0 = Absent
- 2 = Present

Codes

CKF7E01

Ever: Intensity

CKF7001

CKF7X01

Ever: Perpetrator

CKF7101

Intensity

CKF7002

CKF7X02

Perpetrator

CKF7X03

CKF7X04

CKF7X05

CKF8101

CKF8102

CKF8103

Fig. 1. Example of Life Events Interview: Item "Learned about an event that caused, or had potential to cause, severe injury or death."

Definitions and questions

VICTIM OF PHYSICAL VIOLENCE (NOT ABUSE)

Subject has been the victim of physical violence, with one or more people using force against the subject with potential to cause death or serious injury. Force may have been used in order to get something (e.g. mugging, robbery), or to intimidate or frighten subject, or for its own sake (assault, fight, torture). Victim may have been threatened with a weapon.

CODE PHYSICAL ABUSE BY FAMILY MEMBER
SEPARATELY (PAGE 364)

**Has anyone ever hit or hurt you badly?*

**Has anyone ever robbed or mugged you?*

Or beaten you up really badly?

What happened?

Did they threaten you with a weapon?

Why did they do it?

Do you know who did it?

Coding rules

EVER:VICTIM OF PHYSICAL VIOLENCE

- 0 = Absent
2 = Some physical injury (e.g. black eye, cuts), or force with potential for such.
3 = Serious injury (e.g. broken limb, unconsciousness, hospitalization), or force with potential for such.

EVER:PERSON USING FORCE

- 2 = Known peer
3 = Known non-familial adult
4 = Unknown adult
5 = Unknown peer
6 = More than one person

EVER:THREATENED WITH WEAPON

- 0 = Absent
2 = Weapon used to threaten but not to hurt victim,
3 = Weapon used to threaten and injure victim

VICTIM OF PHYSICAL VIOLENCE

- 0 = Absent
2 = Some physical injury (e.g. black eye, cuts), or force with potential for such.
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6 = More than one person

THREATENED WITH WEAPON

- 0 = Absent
2 = Weapon used to threaten but not to hurt victim
3 = Weapon used to threaten and injure victim

Codes

CKG3E01

Ever: Intensity

CKG3V01

Ever: Frequency

CKG3O01

Ever: Onset

 /
CKG3X01

Relationship

CKG3E02

Weapon

CKG3I01

Intensity

CKG3F01

Frequency

CKG3O02

Onset

 /
CKG3X02

Relationship

CKG3I02

Weapon

Fig. 2. Example of Life Events Interview: Item "Victim of physical violence."

of clinical interviews with those of highly structured “epidemiologic” interview methods. Although using a highly structured format of questions and probes, the interviewer-based approach trains the interviewer to make sure that the parent or child being interviewed understands the construct under review, and has provided enough detail and examples for a clear rating of the clinical severity of each symptom to be made. A detailed Glossary provides the operational rules for identifying each symptom and event. Thus, although the interviewer is trained to use discretion in adjusting the questioning to the child’s age and stage of cognitive development, she/he is bound to apply the Glossary’s strictly defined, operational criteria for the presence of any event or symptom at the level of clinical severity appropriate for coding it as present for the purposes of diagnosis. The interviewer is expected to question until she/he can decide whether a symptom meeting this definition is present. Once the interview has been coded and checked for accuracy by a supervisor, the data are entered and scored using programs written in SAS that translate the symptom and event codings into scale scores, *DSM* diagnoses, etc. Each potentially traumatic event is scored as present depending on its severity, the closeness of the affected individual to the index child, and a range of other criteria. (Copies of the interview, glossary, and scoring algorithms are available on request from the first author.)

The CAPA interviews parent and child separately, using different interviewers. The presence of a symptom or an event can be determined on the basis of information from a single respondent, or using the either–or rule common in clinical practice. In this paper, we counted an event or symptom as present if reported by either parent or child or both. The time frame of the CAPA for determining the presence of most psychiatric symptoms is the past 3 months. In the case of a few rare and severe acts, such as fire-setting or assault, a lifetime frame of reference is used, as required by *DSM-IV*. In the case of potentially traumatic events, we set the time frame for high magnitude events to lifetime, and for low magnitude events to 3 months.

A test-retest study of the Life Events and PTSD module (Costello, Angold, March, & Fairbank, 1998a) found that recall was reasonably reliable in children aged 7–16, and parents. Intraclass correlations were .74 for high magnitude events and .63 for low magnitude events. Kappas for individual events ranged from .40 to .84.

Vulnerability

A 17-item vulnerability scale (see Appendix B) was created to reflect ongoing difficulties in the child’s life and

family that could increase exposure to potentially traumatic events, or reduce the level of support available following such an event. The vulnerability scale was constructed from characteristics of the child’s background known from previous analyses (Costello, Farmer, Angold, Burns, & Erkanli, 1997) to increase risk of psychiatric disorders. Factor analysis with varimax rotation identified three distinct groups of variables: *parental psychopathology*, *family relationship problems* (e.g., lack of communication), and *family environment problems* (e.g. poverty).

Further details of the design and psychometric properties of the CAPA and the Life Events Interview can be found in other publications (Angold & Costello, 1995b; Angold et al., 1995; Costello et al., 1998a).

Procedure

Interviewers were residents of the area in which the study is taking place. All had at least bachelor level degrees. They received 1 month of training and constant quality control, maintained by postinterview reviews of each schedule, notes, and tape recordings by experienced interviewer supervisors and study faculty. Interviewers were trained by Department of Social Services staff in the State’s requirements for reporting abuse or neglect, and all suspected cases were referred to the appropriate agency.

Families were visited by two interviewers, either at home or in a location convenient for them. Before the interviews began, parent and child signed informed consent forms. They were then interviewed in separate rooms. Each parent and child was paid \$10 after the interview.

Data Management and Analysis

Scoring programs for the CAPA, written in SAS, combine information about the date of onset, duration, and intensity of each event and symptom to create scale scores and diagnoses (available from the first author on request).

Three major objectives guided the choice of statistical models for longitudinal and multilevel data. The first goal was to apply familiar regression methods relating the response variables to the explanatory variables; the second goal was to account for the within subject and/or cluster correlation across waves; and the third goal was to account for the design effects due to the sampling strategy employed. Zeger and Liang (1992) describe a marginal model approach (GEE) to the analysis of longitudinal data. GEE is a methodology developed for dealing with

complex longitudinal, repeated, or clustered data, where the observations within each cluster are correlated with each other (Diggle et al., 1994). The parameter estimates are obtained by minimizing a score function that is a generalization of the weighted least squares approach. In fact, if the outcome variables were normally distributed (i.e., bell-shaped) then GEE would give the results that would have been obtained by using standard Maximum Likelihood method or weighted linear least square regression. GEE models the effects of predictors (i.e., covariates) on the marginal expectations (i.e., means), while also accounting for the associations (correlations) among observations from each subject. That is, Generalized Estimation Equation (GEE) fits a generalized regression model for longitudinal data where the focus of estimation concentrates on the marginal (population) estimates. In this paper we use GEE to provide estimates for the overall population odds ratios for associations between the high magnitude events and low magnitude events and vulnerabilities, as well as the general population characteristics such as sex, age, and race. In addition, GEE provides unbiased prevalence estimates and confidence intervals.

As an example, consider the marginal expectation that the outcome variable Y is related to a set of predictor variables via a link function, denoted as g :

$$E(Y_{it}) = \mu_{it}'$$

$$g(\mu_{it}) = x_{it}^T \beta.$$

The subscript i refers to individual, and the subscript t refers to time-point for a longitudinal analysis. Commonly used link functions for binary outcomes are the probit and logit. The marginal variance of the outcome variable is a function of the marginal mean. Another parameter, called an over-dispersion parameter and denoted as ϕ , accounts for the extra variability in the outcome unexplained by the mean.

$$\text{var}(Y_{it}) = v(\mu_{it})\phi.$$

The covariance between observations is a function of the marginal means and additional parameters.

$$\text{cov}(Y_{is}, Y_{it}) = c(\mu_{is}, \mu_{it}; \alpha),$$

where v and c are known functions. Marginal regression coefficients have the same interpretation as in a cross-sectional study. For example, suppose we are interested in whether risk of having a high magnitude event is related to presence of a vulnerability factor in the preceding 3 months. A marginal model might be the logistic regression:

$$(\mu_{it}) = \beta_0 + \beta_1 \text{stress}_{it} + \beta_2 \text{age},$$

$$\text{var}(Y_{it}) = \mu_{it}(1 - \mu_{it}),$$

$$\text{corr}(Y_{is}, Y_{it}) = \alpha_{|s-t|}, s < t.$$

In the first equation

$$\mu_{it} = E(Y_{it}) = P(Y_{it} = 1),$$

where Y_{it} indicates whether or not the individual has a high magnitude event at time t . Here vul_{it} is an indicator variable for whether or not the subject had a positive score on the vulnerability index in the past 3 months, and age is the age of the individual at the baseline ($t = 1$). The correlation between two observations on the same individual depends on the length of time between the two observations. Upon exponentiating we obtain, e^{β_1} , which is approximately the ratio of prevalences of individuals with high magnitude events, from those individuals with and without a vulnerability factor. These regression coefficients are called “population-averaged” because they provide the odds of the outcome for populations with and without the risk factor.

In our analyses, the events and vulnerabilities were subject-specific predictors (covariates) that vary over time, while age, gender, and race/ethnicity were determined at baseline. The association between traumatic events and age, gender, race/ethnicity, and family vulnerability factors was predicted by a multiple logistic regression model. Computations were performed using GEE approach with a logistic link function as illustrated above. We did not specify the correlation function *a priori*, but let the GEE estimate it. This was achieved in the SAS program GENMOD by defining the type of the correlation as *unstructured*.

The logistic regression models were run for the dichotomized high magnitude event outcomes. These models were implemented using GEE in the SAS program PROC GENMOD. We also used the robust variance estimates (i.e., sandwich type estimates) in GENMOD, together with sampling weights, to adjust the standard errors of the parameter estimates to account for the two-phase sampling design. Thus, the use of multiwave data with the appropriate sample weights (as described in *Study Sample* above) capitalized on the multiple observation points over time, while controlling for the effect on variance estimates of repeated measures on the same child, and for design effects.

To obtain the prevalence of each of the high and low magnitude events we fitted logistic regression models with no predictors but including the intercept only. GEE produces an estimate α^* of the intercept α and its standard error $\text{SE}(\alpha^*)$. Because in this case intercept was just the logit of $p = \Pr(Y = 1)$, we converted the logit to the prevalence p of the event $Y = 1$: $p = \exp(\alpha) / \{1 + \exp(\alpha)\}$ (evaluated at the estimate α^*). Using the Delta method

(Taylor's series expansion) the standard error of p^* is obtained as $\{p^*(1 - p^*)\} \cdot SE(\alpha^*)$. Note that this gives an overall (time-averaged) prevalence estimate, corrected for within-subject correlations as well as design effects, reflected in the estimate α^* (hence p^*) and $SE(\alpha^*)$ [hence $SE(p^*)$].

To obtain the estimates of prevalence for each wave, we introduced Wave as a class variable in PROC GENMOD, and then fit the simple logistic models above without the intercept but including Wave as a predictor. Similarly, prevalence of high and low magnitude events for boys and girls were obtained using Sex as a class variable and fitting logistic models without the intercept but including Sex as a predictor. For a generic continuous predictor, x (e.g., age in years), prevalence was obtained using the logistic regression above but keeping both the intercept and x in the model. Converting to a probability scale we obtained the prevalence as a function of x : $p(x) = \exp(\alpha + \beta x) / \{1 + \exp(\alpha + \beta x)\}$. Note that the slope parameter β is the log-odds ratio for the event $Y = 1$ versus event $Y = 0$ associated with a unit increment in the predictor x . The standard error of $p(x)$ can be obtained using the Delta method as above as a function of x and involves the estimated covariance between the intercept and slope.

Results

Prevalence of Exposure to a Potentially Traumatic Event

High Magnitude Events

Table 1 shows the percent prevalence of each event in the list of high magnitude events, for the child's lifetime (first three columns) and in the past 3 months (last three columns) by sex and for the whole sample. Table 1 also shows the mean number of events reported, and the prevalence of one or more events. Although each individual event was reported rarely, the cumulative effect was considerable: one in four children reported one or more lifetime events falling into the high magnitude or extreme stressor category. Of the 25% of children reporting an extreme stressor, the majority (72%) had only one during their lives, 18% reported two such events, and the remaining 10% had three or more. The most commonly reported high magnitude events were death of a loved one (parent, caretaker, sibling, or best friend), witnessing a traumatic event, learning about a traumatic event, and sexual abuse. Girls were significantly more likely than boys to report rape, sexual abuse, or coercion. Boys more often reported causing death or severe harm to someone else. However,

Table 1. Percent Prevalence of High Magnitude Events in a Population Sample of Youth

Event	Lifetime			Past 3 months		
	Girls	Boys	Total	Girls	Boys	Total
Death of a loved one	5.0	4.7	4.8	1.4	0.8	1.1
Witness to event	4.8	4.9	4.9	1.1	1.2	1.2
Learned about event	5.1	4.3	4.7	1.0	1.3	1.2
Serious illness	2.0	2.5	2.2	0.6	1.0	0.8
Serious accident	2.0	2.4	2.2	0.4	0.5	0.3
Natural disaster	1.9	2.3	2.1	<0.1	0.3 ^a	0.2
Fire	1.2	1.1	1.2	0.3	0.3	0.4
War, terrorism	0.2	0.2	0.2	0.0	0.0	0.0
Toxic exposure	0.7	0.5	0.6	0.3	0.3	0.3
Cause of death or harm	<0.1	0.2 ^b	0.1	0.0	0.2	0.1
Violence (nonfamily)	0.4 ^a	0.8	0.6	<0.1	0.3	0.2
Violence (family)	1.2 ^b	0.5	0.8	0.6	0.1	0.4
Captivity	0.2	0.1	0.2	0.0	0.0	0.0
Sexual abuse	3.4 ^a	1.8	2.6	0.4	<0.1	0.2
Rape	0.4 ^b	<0.01	0.2	<0.1	0.0	0.1
Coercion	0.8 ^b	0.4	0.6	<0.1	<0.1	<0.1
Mean number of events	0.4	0.3	0.4	0.1	0.1	0.1
(SD)	(0.8)	(0.7)	(0.8)	(0.3)	(0.3)	(0.3)
One or more events	25.2	24.8	25.1	6.3	6.0	6.2

Note. Prevalences are weighted percent estimates using sampling weights described in the text.

^aEvent significantly commoner in the marked sex: $p < .001$.

^bEvent significantly commoner in the marked sex: $p < .01$. Statistical tests are based on the robust Z-scores for the log-odds ratios estimated using a GEE model with logit link for binary outcomes.

there was no sex difference in the mean number of high magnitude events reported, or in the likelihood of one or more such events during the child's lifetime.

Within the 3-month period preceding the interview, 6% of children of each sex experienced a high magnitude traumatic event. Of those reporting a recent event, 94% reported only a single event. The most common recent events were the same as the most common lifetime events: death of a loved one, and witnessing or learning about a traumatic event occurring to someone else.

Low Magnitude Events

More than one in four of the children reported one or more low magnitude events during the 3 months preceding the interview (Table 2). Of those reporting a recent event, 71% reported only one event, 21% reported two, and 8% reported three or more. Events reported most frequently were moving house, changing school outside the normal school transitions, breaking up with a boyfriend or girlfriend, and a marked drop in the family's standard of living. Girls were significantly more likely to report pregnancy than boys were to report having made someone pregnant. Girls were also more likely than boys to report parental separation and breakups with best friends or boyfriends.

Table 2. Percent Prevalence of Low Magnitude Events During the Past 3 Months

Event	Past 3 months		
	Girls	Boys	Total
New child in home	2.3	2.6	2.5
Pregnancy	2.4 ^a	0.2	1.1
Parental separation	1.5 ^a	0.6	1.1
Parental divorce	0.4	0.7	0.5
New parental figure	0.8	1.1	1.0
Moved house	5.5	6.7	6.2
Changed school	4.2	3.5	3.8
Lost best friend through move	2.9	3.6	3.3
Breakup with best friend	3.5 ^a	1.2	2.3
Breakup with girl/boyfriend	5.1 ^a	2.2	3.6
Parental arrest	0.9	1.3	1.1
Reduced standard of living	3.7	4.1	3.9
Forced separation from home	1.3	1.3	1.3
Other	7.2	5.5	6.3
Mean number of events (<i>SD</i>)	0.4 (0.8)	0.4 (0.6)	0.4 (0.7)
One or more events	29.1	28.6	28.9

Note. Prevalences are weighted percent estimates based on the sampling weights described in the text.

^aEvent significantly commoner in the marked sex: $p < .001$. Statistical tests are based on the robust Z-scores for the log-odds ratios estimated using a GEE model with logit link for the binary outcomes and robust variance estimates with the sampling weights to adjust for design effects.

Again, there was no sex difference in the mean number of events reported or the likelihood of reporting one or more.

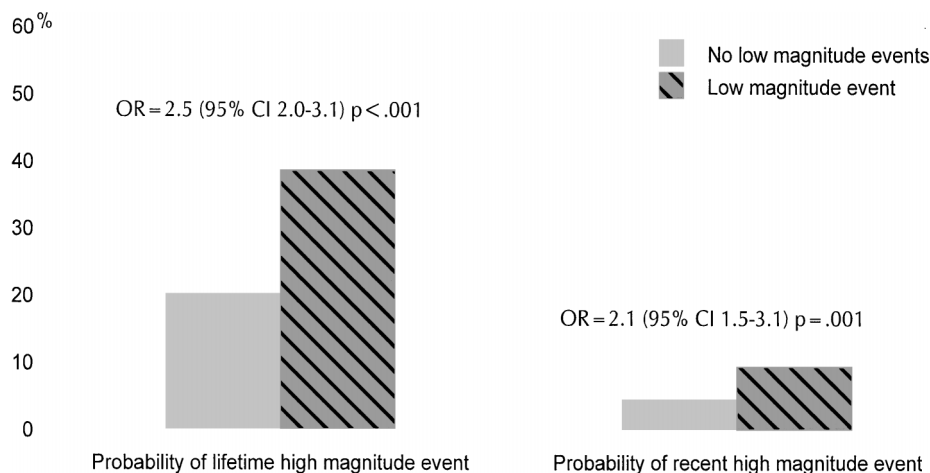
Association Between High and Low Magnitude Events

There was a moderate correlation ($r = .21$) between risk for low and high magnitude events. Over half of the children (57%) had neither a high nor a low magnitude event; 18% reported only one or more low magnitude events; 14% reported only high magnitude events, while

11% reported both. As Fig. 3 shows, recent low magnitude events were more likely in children with a history of one or more high magnitude events. There was also a significant concurrent association between events occurring in the 3 months immediately preceding the interview; a high magnitude event was twice as likely for children who reported a recent low magnitude event, and vice versa.

Vulnerability to Potentially Traumatic Events

There was a linear effect of increasing background vulnerability on the likelihood of high and low magnitude events for boys and girls (Fig. 4). Children with no vulnerability factors had less than a 12% chance of having experienced a high magnitude event during their lifetime, whereas the risk for the most vulnerable children rose to almost 60%. Increasing background vulnerability also linearly increased exposure to low magnitude events, from 13% in the absence of any vulnerability factors to 57% in the presence of 10 or more (OR = 1.13, 95% CI = 1.10–1.15, $p < .001$). In the absence of a low magnitude event, vulnerability affected the risk of a high magnitude event in the 3 months before the interview, increasing it from 14% when vulnerability was lowest to 49% at 10 or more vulnerability factors. The risk of a recent high magnitude event in children who had recently experienced a low magnitude event increased fourfold, from 24% at no vulnerability factors to 92% at 10 or more. In a logistic model of the effect of vulnerability and low magnitude events on the probability of a high magnitude, risk increased 22% with each vulnerability factor, and 57% with each low magnitude event. The interaction term was not significant.

**Fig. 3.** Association between high magnitude and low magnitude events.

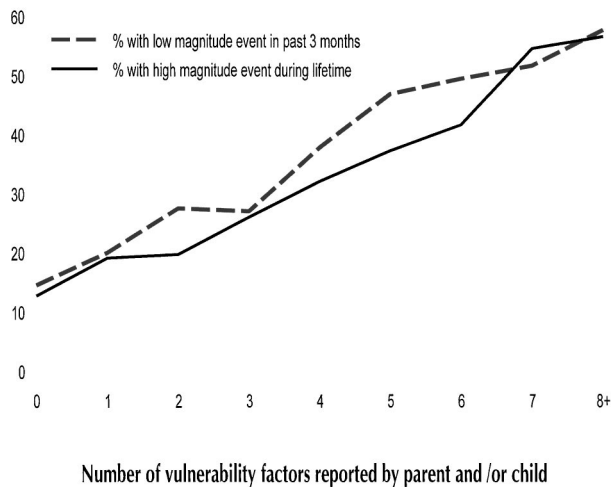


Fig. 4. Effect of increasing vulnerability on risk of high and low magnitude events.

We next examined the effect of each specific vulnerability factor. With the exception of having one or more parents aged 18 or less, each factor significantly increased the likelihood of exposure to both high and low magnitude events. However, there was a great deal of correlation among vulnerability factors; for example, low parental education greatly increased the risk of being below the federal poverty line. To see which types of vulnerability had the greatest impact on potentially traumatic events, we entered the three types of vulnerability—parental psychopathology, family relationships, and family environment—into the regression equation for high magnitude events, controlling for low magnitude events and the effect of the number of vulnerability factors (Table 3, model 4). Parental psychopathology and family relationship problems both contributed independently to the model, but adversity and community factors did not.

Impact of Vulnerability on Individual High Magnitude Events

We examined the relationship between vulnerability and each of the high magnitude events, using the multiple logistic regression modeling described earlier. Some events were distributed throughout the population irrespective of the level of vulnerability; these included deaths of loved ones, serious illnesses and accidents, and physical (nonsexual) violence. Events whose likelihood increased significantly in vulnerable children were sexual abuse, and events occurring to people whom the child knew, or knew about. It seems that what have been called *network events* (Kessler & McLeod, 1984) were particularly common in the lives of vulnerable children.

Effect of Gender on Vulnerability to Traumatic Events

There was a marked difference between boys and girls in the factors that increased their risk for potentially traumatic events. The only types of vulnerability factors that significantly increased boys' risk were those associated with a parental history of mental illness. Each problem of this type doubled the risk of a high magnitude event ($OR = 2.1$, 95% $CI = 1.5\text{--}3.0$, $p < .001$).

In the case of girls, risk factors were more broadly spread across different types of vulnerability. Like boys, girls from families with a history of mental illness were more likely to be exposed to traumatic events ($OR = 3.2$, 95% $CI = 2.3\text{--}4.5$, $p < .001$). Girls whose parents had a criminal record were also at increased risk ($OR = 1.7$, 95% $CI = 1.1\text{--}2.6$, $p = .05$) as were girls from impoverished or poorly educated homes ($OR = 2.3$, 95% $CI = 1.5\text{--}3.5$, $p < .001$). In neither sex was risk of high magnitude events increased by a parental history of drug problems.

Table 3. Modeling Risk for One or More High Magnitude Events

	OR (95% CI)			
	Model 1	Model 2	Model 3	Model 4
Age	0.93 (0.88, 0.98)	0.94 (0.89, 0.99)	0.94 (0.89, 0.99)	0.96 (0.91, 1.02)
Sex (1 = male)	0.96 (0.76, 1.23)	0.97 (0.76, 1.23)	0.97 (0.76, 1.24)	0.98 (0.77, 1.26)
Race-ethnicity (1 = White)	1.09 (0.89, 1.31)	1.05 (0.87, 1.27)	1.00 (0.83, 1.22)	1.03 (0.85, 1.26)
Low magnitude event	—	1.69* (1.38, 2.05)	1.64* (1.34, 2.01)	1.57* (1.28, 1.95)
Vulnerability factor	—	—	1.86* (1.39, 2.48)	1.35 (0.95, 1.93)
Parental psychopathology	—	—	—	1.76* (1.29, 2.41)
Family relationship problems	—	—	—	1.46* (1.17, 1.83)
Family/community environment	—	—	—	1.18 (0.86, 1.62)
χ^2 change	—	110.4, $df = 1$, $p < .001$	236.4, $df = 1$, $p < .001$	68.4, $df = 3$, $p < .001$

Note. These results were obtained using GEE with logit link and robust variance estimates with the sampling weights to adjust for design effects.

* $p < .001$.

When we examined sex differences in which high magnitude events were affected by vulnerability, we found that although the vulnerability factors were somewhat different for boys and girls, the events that they affected were not. Thus, sexual abuse and network events were the events most likely to occur to vulnerable girls and boys.

Effects of Race–Ethnicity on Exposure to Traumatic Events

American Indian and White children had almost identical risk of a lifetime high magnitude event (25.1% compared with 24.7%). African American children were more likely to report a high magnitude event (31.4%), but the difference was not statistically significant in this small sample. The pattern of risk factors was similar for all races.

Discussion

An important conclusion to be drawn from this paper is that potentially traumatic events, of the type described in the *DSM* as extreme stressors, are far from rare in the lives of children in the community. Such experiences have occurred to one-quarter of the children in the Great Smoky Mountains study, who live in a fairly remote and relatively peaceful rural area. Even if we restricted our inquiries to the 3 months immediately preceding each study interview, 6% of children on average experienced such an event. Our exposure prevalence estimates are generally supported by the findings of general population studies of youth that have used retrospective assessment of exposure (Cuffe et al., 1998; Giaconia et al., 1995). This is, however, the first population study to include a detailed assessment of low magnitude as well as high magnitude events, and to be able to examine their interrelationship with a wide range of background vulnerability factors. Thus, it was possible to demonstrate that vulnerability factors such as poverty increase the risk of some events (sexual abuse, network events) but not others (deaths of loved ones, serious illness, or accidents).

Our findings replicate the clinical observation that exposure to traumatic events is not randomly distributed among children in the general population. For both boys and girls, a family history of mental illness doubled the risk of exposure. There was a *gradient of vulnerability*, such that risk for exposure increased from one in eight of the most fortunate children to over half of the most vulnerable. In addition, the finding that children experiencing one or more low magnitude events were at greater risk of a high magnitude event during the same period of

time provides some support for the hypothesis that low and high magnitude events cluster in time.

Despite substantial methodological differences among the various general population studies of children and adolescents, our findings are in good agreement with those of earlier studies (Boney-McCoy & Finkelhor, 1995; Brown et al., 1998; Cuffe et al., 1998; Giaconia et al., 1995; Kilpatrick et al., 1998) in pointing to the important and continuing public health problem of children's exposure to high magnitude stressor events.

These analyses also enable us to build up a picture of children in the general population who were at highest risk of suffering potentially traumatic events. Boys and girls were equally exposed to such events, and children from families with a history of mental illness were particularly vulnerable. Girls were also put at increased risk if either of their parents had a criminal record or if the home was particularly poor or disorganized. Sexual abuse and network events were significantly more common in the lives of vulnerable children, while the risk of family deaths, serious accidents and illness, and physical violence were spread across the population without regard to vulnerability. However, it is worth noting that even among the most fortunate group of children whose lives were free from vulnerability factors, one in six had suffered at least one traumatic event.

From both a clinical and a research point of view, this study of a general population sample is important in demonstrating that the exposed children who are seen by mental health professionals, and who have been the source of most of the published data on traumatic exposure and its consequences, are only a small proportion of all exposed children. Several studies have shown that only about 4% of children see a mental health professional for any reason within any 3-month period (Burns et al., 1995; Farmer, Stangl, Burns, Costello, & Angold, 1999), fewer than experienced a high magnitude traumatic event in this study. Furthermore, there is much evidence that access to services is affected by many factors, including parental pathology, previous psychiatric history, and insurance status (Costello, Pescosolido, Angold, & Burns, 1998b; Cunningham & Freiman, 1996; Gans, McManus, & Newacheck, 1991; McManus & Friesen, 1989). For all these reasons it is unlikely that the consequences of exposure to extreme stressors are necessarily the same for clinic attenders as for other children.

Limitations

Among the limitations of this study are its setting in a predominantly rural area of the United States, and its

racial distribution, which mirrors that of the study area, but includes very few African American children, and virtually no Latino or Asian American children. We are currently replicating the study in another rural area where about half of the sample is African American. A third limitation is the reliance on self-report and parent-report for information about the events as well as other factors; it was not feasible to seek independent corroboration (although circumstantial evidence was sought by the interviewer, and respondents' accounts of events were usually quite convincing). The fact that test-retest reliability was quite high, especially for high magnitude events, is reassuring (Costello et al., 1998a), but ideally one would like to be able to validate these reports against court and hospital records, death certificates, and other documents of record.

The reasons for developing a new measure of exposure to traumatic events are discussed elsewhere (Costello et al., 1998a). The measures designed for community studies on the whole lack the detail that we sought, and are restricted to the *DSM's* "extreme stressors." We were interested in testing the assumption that the same set of events serve as precursors of posttraumatic stress disorder in children or adolescents as in adults. We did not select one of the standard measures of traumatic exposure used in clinical studies for the same reason, and also because these are logically based on the assumption of exposure, which does not hold in a general population study. Thus, the measure used differs from those employed in many of the previously published studies, and so the results may not be directly comparable.

Despite these limitations, we believe that the study is useful in providing data on the prevalence of traumatic events in the general population, based on 5,000 pairs of parent and child interviews, covering middle childhood to adolescence, and including relevant data on vulnerability factors, demographics, and service use. We hope that it will serve as a useful counterweight to the high degree of reliance on clinical samples, or samples selected following one specific traumatic event, in reminding us that although any particular traumatic event is fortunately rare, a large minority of children will be forced to cope with one or more such traumas before they reach adulthood.

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